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HEALTH CARE ADMINISTRATION

USE OF THE REMOTE CLINICAL COMMUNICATIONS SYSTEM AT LANDSTUHL ARMY REGIONAL MEDICAL CENTER

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As Department of Defense dollars shrink, Army Medical Department personnel must find cost-effective methods to deliver quality medical care to beneficiaries stationed where medical specialists are not assigned. While general practice physicians are available in these areas, specialists are centrally located at major medical centers. Currently, the normal method for providing a specialty consult is to aeromedically evacuate the patient to the medical center. Many times, the patient requires only a clinic visit. However, evacuation costs represent thirty to fifty times the visit cost. With rapid advances in computer and telecommunications technology, it is now possible for a patient to receive a medical consult from a specialty physician located thousands of miles away.

This study determined whether the Remote Clinical Consultation System (RCCS), was a cost-effective method of providing consults. The average cost of evacuating 353 outpatients to Landstuhl Army Regional Medical Center (LARMC) was $2963.05. Were these patients treated using RCCS, the cost would have been $264.65, saving $2698.40. Installing RCCS at one site costs $16,533.00, therefore a clinic must consult seven patients to break-even. Analysis of referral rates indicates that military clinics/hospitals in Europe will meet this break-even point.

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ABSTRACT

As U.S. Department of Defense dollars shrink, Army Medical Department personnel must find cost-effective methods to deliver quality medical care to beneficiaries stationed in areas where medical specialists are not assigned. While general practice physicians are available in these areas, specialists are centrally located at major medical centers. Currently, the normal method for providing a specialty consult is to aeromedically evacuate the patient to the medical center. Many times, the patient requires only a clinic visit. However, evacuation costs represent thirty to fifty times the visit cost. With rapid advances in computer and telecommunications technology, it is now possible for a patient to receive a medical consult from a specialty physician located thousands of miles away.

This study determined whether such a system, the Remote Clinical Consultation System (RCCS), was a cost-effective method of providing consults. The average cost of evacuating 353 outpatients to Landstuhl Army Regional Medical Center (LARMC) was $2963.05. If these patients were treated using RCCS, the average cost would have been $264.65, a savings of $2698.40. Installing RCCS at one site costs $16,533.00. Therefore, RCCS must be used for seven or more patients to break-even. Analysis of referral rates indicates that all military clinics/hospitals in Europe will meet this break-even point, except one. In fact, this

break-even point will be met after approximately four months. The rapid payback time suggests that RCCS could be installed at most of LARMC's outlying clinics, which do not aeromedically evacuate patients to LARMC for treatment. This will cause less inconvenience for the patients treated by these clinics, as they may not be required to travel at their own expense to LARMC for a consult. Additionally, as more patients receive consults via RCCS, more appointments may become available within LARMC's specialty clinics.

Utilization of RCCS allows for quality care, at a reduced cost, with increased access to LARMC's specialty clinics as more patients receive consults through telecommunications.

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CHAPTER 1

INTRODUCTION

CONDITIONS WHICH PROMPTED THE STUDY

During Operation Provide Promise, United Nations soldiers deployed to Croatia received support from a U.S. Military Field Medical Facility. In November 1992, the 212th Mobile Army Surgical Hospital (MASH) deployed from Wiesbaden, Germany to fulfill this supporting mission. In May 1993, the 502nd MASH from Landstuhl, Germany replaced the 212th MASH. Currently, the 48th Air Transportable Hospital (ATH), an Air Force field hospital, provides medical support.

These hospitals, particularly the 212th and 502nd MASH, are not unlike 4077 MASH of M*A*S*H, the popular movie and television show. A MASH provides life sustaining/saving surgical procedures and prepares patients for evacuation to more specialized, tertiary medical facilities. The phrase "Meatball Surgery" used by CPT Hawkeye Pierce (Alan Alda) on M*A*S*H best describes the surgical abilities of a MASH. Because of its limited surgical mission, a MASH contains few surgical specialties. Therefore, a requirement to evacuate patients to a higher echelon level of care exists. With assistance from more specialized surgeons; however,

evacuation may be unnecessary if the ability to receive consultation from these specialties exists.

Supporting the hospitals in Croatia in this consulting role is the 2nd General Hospital, or Landstuhl Army Regional Medical Center (LARMC) located at Landstuhl, Germany. LARMC is currently in the process of divesting its 2nd General Hospital role and becoming a pure Table of Distribution and Allowances (TDA) facility with the mission of providing definitive care within Europe. LARMC's wide range of services contain a number of subspecialties that provide consultations to the deployed hospitals, and receive evacuated patients.

In May 1993, the Remote Clinical Communications System (RCCS) began operation. RCCS allows attending physicians in Zagreb to interact with a consulting physician at LARMC. RCCS is a computer system that uses Adobe Photoshop, a commercially developed computer program that allows pictures to be digitally manipulated. The remote site uses a KODAK DCS 200 Digital Camera to take pictures of a wound or other aspect of the patient. Rather than imprinting the image on a roll of film, the image is digitally recorded inside the camera. The camera downloads the images into a Macintosh PowerBook 180 computer. The images are then transmitted, using the International Maritime Satellite communications system, to an Apple Macintosh Quadra 950 computer at LARMC. A consulting physician at LARMC can view the file(s) on a 17

inch color monitor, then phone the attending physician to provide alternatives and recommendations for treatment. Additionally, LARMC uses a Kodak 7720 color digital image printer which allows the physician to generate a hardcopy photograph of the file. These features allow the attending physician greater latitude in treatment methodologies.

Along with supporting deployed hospitals, LARMC provides peacetime medical care to approximately 300,000 authorized beneficiaries (Active Duty, Retired Military, and Department of Defense civilian personnel, as well as family members). These beneficiaries live within the US European Command's Area of Responsibility. This area contains 76 countries in Europe, the Mediterranean littoral and Africa.

In accomplishing this mission, the LARMC Commander has been given specific time-frame requirements for seeing referred patients. The Commanding General (CG) of 7th Medical Command (MEDCOM), the senior physician in U.S. Army, Europe (USAREUR), dictated that all active duty consults will be seen within three days, and family members of active duty will be seen within ten days. Currently, there are six U.S. Army Clinics and seven Medical Department Activities (MEDDACs) which require consult services from LARMC. When the current drawdown in Europe is complete on 1 October 1995, there will only be two MEDDACs, Heidelberg and Wurzburg. Additionally, there will be eight US Army Health Clinics, under LARMC's control. These clinics extend from

Brussels, Belgium to Vicenza, Italy. One suggestion to ensure compliance with the CG's directive is to use RCCS in this peacetime mission. RCCS permits the attending physician the ability to consult with LARMC physicians to determine whether the patient must travel to LARMC for treatment. RCCS utility applies to numerous specialties such as ENT, Dermatology, Ophthalmology.

STATEMENT OF THE MANAGEMENT PROBLEM

What is the most cost-effective method of providing medical consultations by numerous specialists at LARMC to attending physicians at remote locations? The two alternatives considered were RCCS and traditional evacuation procedures (i.e., air evacuation). While these two alternatives should be available for use at most locations, there will be some locations where RCCS may not be feasible. In those locations, patient evacuation will be necessary and available for use by the attending physician.

LITERATURE REVIEW

RCCS is a recently fielded medical communications technology which has not received a systematic review by academic journals. Articles have been written about topics related to RCCS, and reviews of RCCS components are available from computer magazines.

Research within the literature developed six general topic areas: components of RCCS, use of automation in direct medical care, telemedicine, teleradiology and telepathology,

military applications of telemedicine, and evaluating financial feasibility.

COMPONENTS OF RCCS

RCCS is a compilation of individual components used by the military to develop a system to provide "real-time, worldwide interactive medical imagery consultative service" (Anonymous 1993). According to the American Hospital (1993) Association, RCCS has a life expectancy of five years.

RCCS uses Adobe Photoshop, a commercially developed, off-the-shelf image editing software. Adobe Systems (1991) describes their program as an "extraordinary photo-retouching, imaging editing, and color painting software," capable of producing professional quality results. The software is capable of performing the following operations on a digital image: cut, paste, transform, resize, modify, and print. MacUser, a computer magazine dedicated to users of Macintosh computers, calls Adobe Publisher the "premier professional level image processing tool" and "the last word in image processing" (Biedny 1993).

Fraser (1993) describes the Kodak 7720 printer as the undisputed champ for printing photographs and producing sharp images with excellent color saturation. He stated that it produced the best transparencies, using vibrant colors while allowing plenty of light to pass through. A

limitation of the printer is in the area of desktop proofing, which is not applicable to telemedical operations.

Probably the most fascinating part of the system is the KODAK DCS 200 Digital Camera. Essentially, it is a camera with a 80 megabyte hard drive that can store up to 50 color images. The camera delivers 24-bit color images at a resolution of 1.5 million pixels, close to the roughly two million grains resolved by standard 35mm film. Critics state that "it beats a conventional 35mm camera -- without the wait for film processing" (Taylor 1994).

In addition to the RCCS link-up between Zagreb and LARMC, Walter Reed Army Medical Center (WRAMC) has a RCCS link-up to a field hospital in Somalia supporting the humanitarian efforts there. Dr. (LTC) Edward R. Gomez, WRAMC's Chief of Vascular Surgery, stated that based on Somalia evacuation data, patients referred to Ophthalmology, Dermatology, Hematology, Endocrinology, and Oncology can be directly impacted by the utilization of RCCS. He added that the specialties of Dermatology, Infectious Disease and Ophthalmology were most commonly consulted. He feels that approximately 25% of all evacuated outpatients could have been treated locally (Gomez 1994).

USE OF AUTOMATION IN DIRECT MEDICAL CARE

The use of telecommunications in healthcare requires changes in the traditional procedures of medical practice, as well as an understanding of "resistances" such as

asymmetry of information within healthcare, distance and cultural differences. These obstacles may explain in part why the healthcare system has not endorsed telemedicine as a way of improving care to rural and isolated communities (Brauer 1992).

Use of telecommunications in the practice of medicine is young, although not necessarily new. As far back as 1964, psychiatric consultations were conducted in Nebraska using two-way closed circuit television. In 1967, the Massachusetts General Hospital provided consultations for employees and passengers at Logan Airport in psychiatry, radiology, and dermatology. Today, a practitioner far from a large city can consult with specialists in distant medical centers using telecommunications. Not only can patients be evaluated on camera, but also special studies such as radiographs, CT scans, ultrasound, and ECGs can be transmitted for discussion and interpretation. Consequently, the lone practitioner no longer has to feel isolated when treating a patient with a medical problem beyond his or her expertise (Rayman 1992).

TELEMEDICINE

Telemedicine has been described as "a technological approach that can be employed to reduce the isolation of rural healthcare practitioners" (Greenfield and Kardaun 1990). Preston, Brown, and Hartley (1992) write that inner-city healthcare delivery systems have incorporated

telemedicine in continuing education programs and in providing healthcare to prisoners. Mun (1989) states that the impact of this explosion of diagnostic imaging extends beyond radiology as digital imaging technology is becoming increasingly important in the following fields: radiation medicine, cardiology, neurosurgery, gastroenterology, ophthalmology, neurology, pathology, orthopedics, plastic (reconstructive) surgery and dentistry.

Preston, Brown and Hartley (1992) further state that the need for telemedicine is obvious in the face of major obstacles to providing a high standard of healthcare. First is the grossly unequal geographic distribution of healthcare personnel and resources. Second is the need for healthcare providers to efficiently keep up with a rapidly changing body of knowledge. It is not feasible to locate medical specialists, the highest-technology equipment, and major information resources in every hospital and clinic. One partial solution is to give healthcare providers access to specialists and information using telecommunications at the time they need it.

Brauer (1992) writes that telemedicine is an emerging technology that is still seen primarily as medium or process (i.e., the 'tele' part) and not yet as the message or content (i.e., the 'medicine' part). Part of the reason for the observed lack of published activity may be that while healthcare practitioners tend to focus on the healthcare

delivery message and technology specialists tend to focus of the 'tele' medium, the two groups have not been working together.

Legal issues associated with telemedicine may hinder full acceptance of the technology. While these issues may be less applicable to military healthcare providers, they are hurdles in the civilian community. For example, if the telemedicine system crosses state lines, what licensure requirements will there be for the consulting physician? (Preston, Brown, and Hartley 1992). These issues have yet to be answered and will not be addressed in this paper since they do not apply to military medicine.

TELERADIOLOGY AND TELEPATHOLOGY

Teleradiology systems electronically transmit radiographic images and consultative text from one site to another. They are often Wide Area Networks (WANs) designed to provide prompt interpretation of radiological images for patients in underserved rural areas, as well as in medical facilities with no full-time radiologist. A WAN is a communication system that extends over larger distances (covering more than a metropolitan area) and often employs multiple communication-link technologies such as copper wire cable, coaxial cable, fiber-optic links, digital switched circuits, and microwave satellite links. WANs can also integrate multiple hospital or clinic health maintenance organizations (Batnitzky et al 1990). Digital images can be

manipulated through spatial filtering, image subtraction, manipulation of image density and contrast, and pixel shifting in such a way that a consulting physician can exploit otherwise latent information contained in each image (Yoshino et al 1992).

It should be noted that many studies are out of date almost as soon as they are published because teleradiology picture archiving and communication systems are constantly being upgraded (Halpern et al 1992). In that regard, Batnitzky et al (1990) write that an increasing number of studies indicate that the minimum monitor pixel size needed for accurate diagnosis is approximately 0.2 mm (2048 X 2048).

Elam et al (1992) reported a lower rate in detecting pneumothoraces using a digital workstation, but equal for conventional and digital (laser-printed) hard copy. The difference in performance with the workstation, however, was of marginal statistical significance (P=0.06). In their study, the monitor resolution was only 1024 X 1536 pixels.

Scott et al (1993) reported that there was a significant difference ($p < .001$) in accuracy of reading film (80.6%) and using teleradiology screens (59.6%). However, the monitor resolution was only 1280 by 1024 pixel, again below what is considered the minimum requirement. The group admitted that the cases used in the study were very complicated cases and not a "representative sample" of a

normal set of cases. However, the group also stated that only difficult cases would require consultation, which was their rationale for the types of cases in their study.

Razavi, Sayre, and Taira (1992) compared 239 pediatric computed chest radiographs interpreted in hard-copy and digital display (2560 X 2048 pixel) formats. No statistically significant differences existed in detection of pneumothoraces or air bronchograms with the two mediums. The digital display demonstrated "a slight performance edge" in detection of interstitial disease and linear atelectasis.

Goldberg et al (1993) studied the diagnostic accuracy of 685 digitally transmitted radiographs and found a diagnostic accuracy rate of 98%, which was an improvement over prior field trials at low and moderate resolution.

Halpern et al (1992) found that teleradiology was overall comparable to film readings in allowing findings to be seen. The group, in an evaluation of interpretations of intravenous urograms using four radiologists, found that each radiologist, reading individually, detected fewer findings on film than were detected by a previous group that set the "gold standard," and detected even fewer findings by teleradiology. However, these differences were small and significant only for one reader. The overall sensitivities (89% for film versus 86% for teleradiology) were not significantly different. The monitor used had a dimension of 2048 X 1684 pixels.

Dwyer et al (1992) wrote that the selection of efficient and cost-effective WANs for use in a teleradiology system is presently more of an art than a science. The essential parameters used in designing any teleradiology system are: (a) image transmission parameters, (b) technical elements (film digitizers, film printers, computer systems, gray-scale workstations), (c) communication links, and (d) number of examinations to be transmitted. Accurate assessment of these four factors is important because these estimates provide the basis to design the system's architecture. The implementation of a teleradiology system requires the resolution of four major issues: (a) estimating the type of images and the transmission load to be placed on the system, (b) selecting cost-effective WANs, (c) designing the architecture of a teleradiology system, and (d) designing the system for education and research purposes.

Besides routine patient consultation, telemedicine has found application in disaster response. In December 1988, a severe earthquake struck Soviet Armenia causing 150,000 casualties and widespread damage. Through appropriate channels, NASA offered aid to the Soviet Union in the form of consultation through telemedicine communications with specialists in the United States who could offer their services in real time to the managing physicians in Soviet Armenia. Through this system, specialists from all major specialty areas in the United States consulted on more than

200 patients. Due to these consultations, approximately 25% of the original diagnoses were changed. Likewise, as a result of these consultations, treatments were altered for 24% of the patients. Additionally, the interpretation of diagnostic studies was altered in 12% of cases (Rayman 1992).

MILITARY APPLICATIONS OF TELEMEDICINE

With armed forces scattered throughout the world (e.g. Central Europe, Bosnia, Somalia, Korea), many physicians find themselves in semi-remote or remote areas. With the ever present danger of disaster and war, medical telecommunications have a number of useful applications in the practice of military medicine: on the battlefield, at disaster sites, for aircraft accident investigation, for peacetime patient care, and for training and education.

Because of the technicalities of broadcasting (i.e., bulky camera equipment, and transmission of electronic signals and programming) and the environment associated with the modern battlefield, telemedicine may not be appropriate within 1st or 2nd echelons of care (Unit and Division Level). However, this application of telemedicine should not be entirely ruled out for future use as technological advances continue to simplify and miniaturize communication equipment. At present, telemedicine would be most effective at 3rd echelon (Corps Level) medical facilities, which are close to the war zone yet far enough away from the chaos of

front line operations. Here, physicians in a relatively calmer environment could consult with other physicians, possibly at 4th or even 5th echelon facilities (Communications Zone and Zone of Interior Level). Telemedicine aboard hospital ships such as the U.S.S. Mercy or U.S.S. Comfort or in the sick bay of aircraft carriers is another consideration (Rayman 1992).

Another way that telemedicine could be used within the military is through continuing education and military training, such as battlefield medicine. Courses could be taught not only with didactic lecture materials, but also by demonstrating invasive techniques. The system would allow for two-way exchange between instructors and physician students (Rayman 1992).

EVALUATING FINANCIAL FEASIBILITY

When proposing a new system or project, a feasibility analysis helps to determine what impact solving the problem has on the financial aspects of the organization today and tomorrow (Thierauf 1987). There are several techniques that an organization can use to evaluate the financial feasibility of a system. Although the most common technique is cost-benefit analysis, other methods include payback analysis, return on total assets, net present value and break-even analysis (Powers, Cheney, and Crow 1990).

Break-even analysis is a simple, yet powerful approach to profit planning. The technique is also commonly referred

to as cost-volume-profit analysis. In general, break-even analysis requires the derivation of various relationships among revenue, fixed costs, and variable costs to determine the units of production (e.g., volume of patients) at which the firm "breaks even." The break-even point is where total revenues equal the summation of fixed and variable costs (Droms 1979).

Total costs include the recurring operational costs, plus the developmental costs that occur only once (i.e., the cost of installing a new system). The substantial fixed costs of a new computer system and relatively low variable costs would result in small incremental increases in costs for higher service volumes (Powers, Cheney, and Crow 1990).

Brigham (1983) states that there are advantages and disadvantages associated with the break-even analysis technique. The advantages are as follows:

EASE OF CALCULATION: This method is easy to calculate and apply.

LIQUIDITY INDICATOR: A characteristic of an investment that may increase its value is its liquidity, or the speed with which it can be converted into cash. This method provides a measure of project liquidity.

RISK INDICATOR: As a rule, we can anticipate near-term events better than we can anticipate events in the more distant future. Projects whose returns come in relatively rapidly are generally less risky than long-term projects,

other things held constant. The break-even point is a relative risk indicator.

The disadvantage of the break-even point analysis is:

IGNORES TIME VALUE OF MONEY: The timing of cash flows is obviously important, yet a dollar in 1999 receives the same weight as a dollar in 1994.

PURPOSE

The purpose of this study was to determine whether RCCS is a cost-effective method of facilitating physician consultations. There were five objectives.

Objective 1. Gather the costs associated with patient evacuation to LARMC for consultation,

Objective 2. Gather the costs associated with implementing RCCS at outlying areas for physician consultation,

Objective 3. Gather the costs of procuring, installing, and maintaining RCCS,

Objective 4. Determine the "break-even" point. This is the number of patients that must use RCCS in lieu of being evacuated to justify the cost of RCCS, and

Objective 5. Determine whether LARMC staff can use RCCS to provide consultations to the number of patients required for the system to break-even.

VARIABLES

This study employed neither classical hypothesis testing, nor the differentiation between the dependent and

independent variables. Rather, the variables were the fixed and variable costs comprising the total cost of a medical consult. Costs can be fixed or variable, as well as direct or indirect. Fixed costs are costs that remain constant regardless of usage, whereas variable costs will change according to usage. Direct costs are specifically traceable to or directly cause the production of a product or service. Indirect costs are associated with the operation of the organization, such as overhead. However, these costs are not directly traceable to any product. Instead, these costs are allocated using accepted finance and accounting principles.

This study did not utilize dependent nor independent variables, as understood in the classical sense. Rather, the variables of interest of this study were the total cost of providing a medical consult, as well as the individual costs that made up the total cost.

The following example represents the steps in the process of evacuating a patient to LARMC for consultation and illustrates the sources for obtaining the costs at each step.

Step 1. A sick or injured patient reports to the nearest Military Treatment Facility (MTF) for treatment. The cost of this care was available from Medical Expense and Performance Reporting System (MEPRS) data.

Step 2. The MTF transports the patient to the appropriate airfield for evacuation. This cost was available from Ramstein Air Force Base (RAFB) Transportation Division using standard vehicle operating costs.

Step 3. The 2nd Aeromedical Evacuation Squadron (AES) transports the patient by aircraft to Ramstein Air Base. This cost uses standard aircraft operating costs divided by the number of patients on the flight to determine the cost per patient. The US Air Force Air Mobility Command (AMC) and 2nd AES developed these standard aircraft operating costs, and provided them to me.

Step 4. The 18th Air Staging Facility (ASF) transports the patient from RAFB to LARMC. This cost was available from RAFB Transportation Division using standard vehicle operating costs.

Step 5. The consulting physician at LARMC treats the patient. The cost of this care was available from MEPRS data.

Step 6. The patient returns to home station using the same evacuation assets that brought them to LARMC. I gathered the costs using the same methodology used to determine the costs of transporting the patient to LARMC.

I also gathered other direct costs associated with patient evacuation. Active duty outpatients evacuated to LARMC are in a Temporary Duty (TDY) status. Instead of being admitted to LARMC, the patient is billeted at the

Ramstein Inn Guest House and receives a per diem to cover the costs of food and lodging. Additionally, the spouse or a family member occasionally accompanies the patient as a "Nonmedical Attendant (NMA)." In this study, the only patients that had an NMA were patients under the age of 18 years. An NMA also receives a per diem to offset food and lodging expenses. This per diem rate is available from the local Finance and Accounting Office. Finally, I also included the cost of time lost due to evacuation. The method for determining this cost is discussed later.

The following represents the process of using RCCS to conduct a medical consult:

1. A sick or injured patient reports to the nearest MTF for treatment. The cost of this care was available from MEPRS data.

2. The physician recognizes a need for consultation and uses RCCS to send a digitized image of the injury to the consulting physician. The cost of this step is the transmission cost of sending the image to LARMC. The Surgeon General's Office, and LARMC's Information Management Division (IMD) provided this cost information.

3. The consulting physician reviews the image, and provides the attending physician with a course of treatment, which the attending physician provides. The cost of this step was available from MEPRS data, which provides the average cost for a physician to treat a patient.

As discussed earlier, variable costs occur through usage. Therefore, as consulting physicians provide more consults, the variable costs will increase. These costs include medical supplies, time, and other resources that MEPRS data includes in its standard cost profiles.

The fixed costs were the equipment, installation, and maintenance costs required for RCCS. While such costs normally occur at the beginning of the systems "life-cycle," they may actually extend throughout the "life-cycle."

The standard cost profiles used in this study included the fixed costs associated with the treatment and evacuation of patients. Some of these costs were facility and aircraft construction costs. Comptrollers and resource managers, using accepted finance and accounting principles, allocate these costs when developing the standard cost profiles.

Additionally, there were indirect costs associated with the processes described earlier. These costs include the wages and salaries of pilots, maintenance crews, administrative personnel, nursing services, and housekeeping. The standard cost profiles that I used included the indirect costs as well as the direct costs of providing consults.

ASSUMPTIONS

To facilitate this study, I made three assumptions.

Assumption 1. The patient will receive the same level of care from both the attending physician and the consulting physician.

Assumption 2. The following formula:

$$1 \text{ Man-hour} = 1 \text{ Month Base Pay} / 176$$

will account for personnel costs (unless standard cost profiles include such costs).

Because numerous comptrollers and resource managers within 7th Medical Command informed me that the Army does not have standard personnel costs, I used this formula, which assumes a 40-hour work week, as a "best-guess" estimate of time costs for military. Some may argue that soldiers are available 24 hours a day, 365 days a year. While I agree that soldiers may work more than 40 hours a week, this formula does not include additional benefits derived by solders. Determining the total benefits and actual hours worked for each individual studied is beyond the scope of this study.

Assumption 3. Because this study uses historical and actual cost figures, I assumed that such costs are reliable and valid. My reasoning is that the Department of Defense uses these figures to justify various activities. For

example, The United States Congress uses MEPRS data to determine the cost of medical care for the military.

HYPOTHESIS

At this point, it is necessary to link costs, which this study measures, to volume, which this study hopes to determine. Both methods of providing a medical consultation incur costs. It is my belief that there is a specific volume where the total costs of providing consultations via RCCS are less than the total costs of aeromedically evacuating patients to LARMC. Additionally, regardless of whether RCCS is a less expensive medium to facilitate a consultation, sufficient volume must occur for RCCS to be considered a feasible alternative.

Therefore, the costs identified in the study were used to test the following set of hypotheses:

$H_0 1$: Break-even volume for RCCS consultations will be greater than or equal to current demand for RCCS consultations.

$H_a 1$: Break-even volume for RCCS consultations will be less than current demand for RCCS consultations.

CHAPTER 2

METHOD AND PROCEDURES

OBJECTIVE 1

Objective 1 was "Gather the costs associated with patient evacuation to LARMC for consultation." I coordinated with numerous activities and agencies to complete this objective.

The first activity contacted was the 2nd AES. This unit recently moved from Rhein-Main Air Base outside Frankfurt to RAFB, located near Landstuhl, both in Germany. The 2nd AES is responsible for handling all medical evacuation for the United States European Command, both intra-theatre and inter-theatre. As stated earlier, this research focused on the inter-theatre outpatients evacuated during 4th Quarter, Fiscal Year 1993 (hereafter referred to as 4-93). CPT Bob Edwards, 2nd AES' Chief, Resource Management Section stated that the information desired was contained in a database system maintained by the unit. This was unexpected, for my assumption was that copies of flight manifests would be provided, requiring a detailed "scrub" to gather the desired data: MTF from which the patient came, date of flight, flight number, clinic to which patient was visiting, rank, and whether an NMA accompanied the patient.

Because the data requested did not include Social Security Numbers, names or any other identifying characteristics, patient anonymity and confidentiality was ensured.

I then contacted the 18th ASF, located at LARMC, which is responsible for transporting patients between RAFB and LARMC. The 18th ASF provided information concerning the type of vehicles used to accomplish this mission. The RAFB Transportation Division provided the cost per mile of operation for each of the three types of vehicles utilized.

Most of the data elements requested were self-explanatory; however, the originating clinic, as well as the destination clinic, were coded using standard clinical codes which CPT Edwards was not familiar with. The Chief of LARMC's Patient Administration Division and the Joint Medical Regulating Office (also located at RAFB) assisted with the translation of these codes. CPT Edwards also provided spreadsheets that contained data on the number of patients, passengers, and the cost per passenger for each flight operated by 2nd AES during 4-93.

Coordination with the MEPRS section of LARMC's Resource Management Division provided the cost of a patient visit for each of the destination clinics. These costs came from MEPRS, and includes supplies, manpower, overhead, and other costs associated with the procedures.

The MEPRS Division, of Resource Management, 7th Medical Command in Heidelberg, Germany (the higher (Corporate)

headquarters of all army medical activities in Europe) provided the cost of an outpatient visit at each of the Army clinics/hospitals from which LARMC received patients during 4-93. These locations were:

Frankfurt MEDDAC, Germany

Nurnberg MEDDAC, Germany

Vicenza MEDDAC, Italy, and

U.S. Army Health Clinic, Camp Darby, Italy.

Coordination with the MEPRS section, Resource Management Division, HQ United States Air Force Europe Surgeon's Office for the MEPRS costs at Air Force Facilities resulted in visit costs for the Family Practice Clinic at the following facilities:

US Air Force Hospital, RAF Lakenheath, United Kingdom

US Air Force Clinic, RAF Upper Heyford, United Kingdom

US Air Force Hospital, Incirlik Air Base, Turkey

US Air Force Clinic, Iraklion Air Station, Greece

US Air Force Clinic, Lajes Field, Azores

US Air Force Hospital, Aviano Air Base, Italy

US Air Force Clinic, Izmir Air Station, Turkey

US Air Force Clinic, San Vito Air Station, Italy

Because I did not know the location of a higher headquarters for the four Naval Hospitals, the MEPRS section at each hospital was contacted to obtain the cost of a visit to the Outpatient Clinic for each of the following hospitals:

Naval Hospital, Sigonella

Naval Hospital, Rota

Naval Hospital, Naples

Branch Medical Clinic, La Maddalena

The Aeromedical Evacuation Section of each hospital's Patient Administration Division (or equivalent) provided information about transporting patients to the MTF and flight line and back. Required information included the vehicle used for the patients in question, the distance to the flightline, and the time required to make the trip. Each hospital was able to provide the information, which they had readily available.

The 7th Medical Command Finance and Accounting Office at Landstuhl, Germany provided the per diem rate for patients coming to LARMC. Because of the Aeromedical Evacuation mission, the guest house at LARMC (the Ramstein Inn) will not accept reservations except for TDY personnel. This is so that rooms will be available for all evacuated patients as well as for the NMAs. Discussions with the guest house manager attested that these individuals were billeted at the guesthouse. Using the daily rate, and the number of days the individual(s) stayed as LARMC, the total per diem authorized for the individual was established.

The final piece of information required for my analysis was the cost of time lost due to evacuation. As stated in earlier assumptions, monthly base pay and a 40-hour work

week were used to determine this cost. A number of Personnel and Resource Management Officers validated these earlier assumptions, stating that there were no standard costs, and that using the formula (expressed previously) was the "Best Guess" available. I had hoped to determine any lost time due to a service member accompanying a family member as an NMA. Unfortunately, 2nd AES' database contained only a numerical field for the number of NMAs per patient, and did not give any other data.

To record and analyze the data, a LOTUS 1-2-3 spreadsheet was created, where each row represented a patient, and the columns each represented a cost in the process. To facilitate entering data, the database function within LOTUS 1-2-3 was used to group the patients by various demographics (clinic of origin, destination clinic, flight, etc.) This function was invaluable as it assisted examination of the data to determine differences in costs due to clinic of origin, destination clinic, and status of patient (active duty versus dependent).

OBJECTIVE 2

Objective 2 was "Gather the costs associated with implementing RCCS at outlying areas for physician consultations." In completing this objective, I used the patients identified in Objective 1 to determine the average treatment costs if RCCS was available and appropriate. It was not within the scope of this study to determine whether

these 353 patients could have actually been referred via RCCS. Rather, for comparison only, I assumed that all 353 could have been treated using RCCS.

The cost of an initial visit was the same for both processes. Additionally, the costs of a consult, whether done in person or over the phone, does not change. When I originally spoke with individuals familiar with MEPRS, I was told that MEPRS tracked patient visits and consultations separately. When I requested the costs for a consultation by a physician, I was told that while these consults where tracked separately, the cost associated with the consult was the same as a patient visit. Therefore, the first two costs I gathered where the identical to two of the costs gathered for the evacuation process.

The third cost determined was the cost of transmitting a RCCS image from the originating site to LARMC. Conversation with the Surgeon General's Office established this cost as the standard cost of a telephone call for the duration of the transmission. I contacted the German Bundespost and found that the cost from the sites used in this study. The Chief of LARMC's Information Management Division (IMD) provided the average transmission time which included the image as well as a written narrative.

OBJECTIVE 3

Objective 3 was "Gather the costs of procuring, installing and maintaining RCCS." This objective was

accomplished with the assistance of COL Miles, LARMC's Deputy Commander for Administration (DCA). COL Miles, without divulging the real purpose, formally tasked LARMC's IMD to provide a cost estimate for procuring, installing, and maintaining RCCS at Vicenza, Italy. The rationale for not divulging the real purpose of the tasking was to ensure objectivity. The Chief, IMD is a proponent of RCCS, having briefed General Officers, as well as the news media.

The site was chosen for a number of reasons. First, it was an Army MTF. To have chosen an Air Force or Navy facility may have raised suspicion within IMD, possibly biasing the results. Second, Vicenza is an MTF that will be in existence after the European drawdown is complete. To have requested the information on a site scheduled to inactivate may have again raised suspicion. Third, because Vicenza is the furthest from LARMC, the expenses involved in installing and maintaining should be at least representative of the other sites, if not the most expensive. Although IMD did ask some clarifying questions, the real intent of the task remained unknown to them.

Initially, a cost estimate of $65,636 was submitted. After reviewing the list of equipment, some pieces were identified as being unnecessary. IMD was asked about the necessity of these items, given information known about RCCS. The result was that by using the Defense Data Network (DDN or commonly called E-Mail), almost $46,000 worth of

equipment (mainly a $45,000 Satellite Transceiver) became unnecessary. Additionally, some of the prices were the Manufacturer's Suggested Retail Price. A review of catalogs from a number of computer vendors that could be used in the procurement process, significantly reduced the overall cost. According to IMD, the cost of equipment, installation, and projected maintenance should not vary by site.

OBJECTIVE 4

The fourth objective "Determine the break-even point" was a simple utilization of basic mathematics. The cost of the processes of using RCCS (Objective 2) was subtracted from the total of the cost of the evacuation process (Objective 1). Dividing this number into the cost of RCCS (Objective 3) and rounding the number up to the nearest whole integer provided the break-even point. The reason for the rounding will be apparent in the following chapter.

OBJECTIVE 5

To accomplish Objective 5, "Determine whether LARMC staff can use RCCS to provide the consultations to the number of patients required for the system to break-even," inferential reasoning was employed via two different methods.

The first method required an analysis of the utilization of RCCS from the supported hospital in Zagreb, Croatia, to determine a projected volume of referrals over the lifetime of RCCS. While some may argue that the

conditions in Zagreb are vastly different from the conditions at a peace-time health clinic, the hospital in Zagreb is staffed with specialists (Orthopedic Surgeons, ENTs, etc.,) that would not normally be found in a self-standing clinic. This reduces the number of referrals that would have occurred had these specialists not been in Zagreb.

The second method comes from the previously referenced study of Dr. (LTC) Gomez, who stated approximately 25% of evacuated outpatients could be successfully treated by RCCS.

CHAPTER 3

RESULTS

The overall result of this study is that RCCS is a cost-effective way to provide consultations to outpatients evacuated to LARMC. Additionally, after analyzing each individual military treatment facility's data, this study also demonstrates that RCCS is a cost-effective method of consulting patients at all but one of the hospitals (Upper Heyford). The following tables display a summary of the data analyses.

The results of this study are presented in two ways. First, Tables 1 and 2 reflect the mean total costs associated respectively with evacuation to LARMC and treatment by RCCS. Table 3 computes the break-even volume. These tables are the basis for determining whether RCCS, as a system, is cost-effective. Additionally, because each site had a different break-even point, Table 4 displays this data for each site.

As shown in Table 1, the average cost of a patient evacuated to LARMC was $2963.05. This table shows the various steps of the process, described earlier, and the costs associated with each step.

TABLE 1.--Cost of Evacuating a Patient to LARMC

Step In Process	Cost
Initial treatment	134.51
Transportation from the clinic to airfield for evacuation.	14.55
Air evacuation costs from airfield to RAFB.	780.03
Transportation from RAFB to LARMC.	1.41
Treatment of patient at LARMC	127.98
Per diem costs while TDY.	325.18
Lost duty time	121.73
Return to home station	945.02
NMA Costs	512.64
TOTAL EVACUATION COSTS	**$2963.05**

Table 2 shows the average cost of treating the patient using RCCS, $264.65. Again, this table demonstrates the various steps of the process, described earlier, and the associated costs. The cost for transmitting the image required information from the German Bundespost. With the exception of Frankfurt and Nurnberg (both of which will be closed by 1 October 1995), a standard unit of cost (.23 Marks) lasts the same amount of time (19 seconds) from each of the sites. According to LARMC's IMD, the average transmission, which includes the image as well as a written

narrative, takes four minutes resulting in an average cost of $2.16.

TABLE 2.--Cost of Using RCCS to Consult a Patient

Step In Process	Cost
Initial treatment	134.51
Transmission of image	2.16
Consultation by LARMC physician and treatment by attending physician	127.98
TOTAL COST OF USING RCCS FOR CONSULT	**$264.65**

The net difference between the two processes ($2698.40), is the amount which RCCS would potentially save on the average case. Dividing the cost of installing RCCS at a given site ($16,533) by the RCCS savings (See Table 3) and rounding up to the nearest whole integer produces the break-even point. This is the number of patients from each clinic that must receive treatment using RCCS during its lifetime for the system to break-even. As stated earlier, the estimated lifetime usefulness for RCCS is five years. In this study, the break-even point is seven patients. The reason for rounding up is that the raw result was 6.13. It is impossible to treat 6.13 patients, and treating six patients will not cause RCCS to break-even.

TABLE 3.--Determination of Break-Even Point

	Cost
Total evacuation costs	$2963.05
Total cost of using RCCS for consult	264.65
Amount saved by using RCCS	2698.40
Cost of RCCS	16533.00
Break-even point (Number of patients)	**7**

This study measured the costs of 353 outpatients evacuated to LARMC. As stated earlier, two methods were used to determine whether LARMC could meet or exceed the break-even point.

The first method required utilization rates from the hospital in Zagreb. During the first eight months of use, 16 images were transmitted, saving the evacuation of the same 16 individuals. If this number (16) were extrapolated into RCCS five year lifetime, 120 individuals from this one site should be consulted via RCCS.

The second method for determining whether LARMC could support the number of consults necessary come from the work of Dr. (LTC) Gomez referenced earlier, where he stated that from his studies, approximately 25% of all evacuated outpatients could be successfully treated by RCCS. Assuming Dr. (LTC) Gomez studies apply to patients referred to LARMC,

88 of the 353 patients could have received a consult using RCCS.

Currently, there are 14 MTFs that refer patients to LARMC using aeromedical evacuation. Of these, three will close by October 1994. Additionally, there are six clinics from which the patients use their own vehicles to drive to LARMC for consultation. Multiplying the number of these clinics (17) by the break-even point (7) results in the number of total patients (119) that must receive a consultation using RCCS to make the complete system break-even. These 119 patients can come from any of the clinics. Assuming the number of patients that can receive a consult using RCCS instead of by aeromedical evacuation remains constant (88), RCCS will save the amount of money necessary to pay itself in approximately four months.

As stated earlier, a break-even analysis was performed for each site. Additionally, I again determined how long each site would take to break-even, assuming that the number of patients requiring consultations each quarter is similar to those required during the quarter studied. As before, the break-even time assumes that the results of Dr. (LTC) Gomez study are valid, i.e., 25% of all evacuees are treatable using RCCS.

Table 4 illustrates the costs, break-even point and payback period (in months) for each of the MTFs studied. The figure for equipment, installation and maintenance,

approximately $16,533.00 for each site, was not included due to lack of space. The pay-back period was determined by taking the number of patients aeromedically evacuated to LARMC during 4-93, multiplying that number by .25, and dividing the result by three to ascertain the number of patients who should be consulted via RCCS per month. This final result was added to itself until it reached the break-even point.

As shown in the table, only the hospital at RAF Upper Heyford would not reach the break-even point within the five year (60 month) lifetime of RCCS. All other MTF's reach their break-even point within the first year, some in the first quarter.

Table 4.--Break-Even Point and Payback Period for Each Site

Site	Evacuation costs	Consult cost using RCCS	Amount saved using RCCS	Break-even point	Payback period (months)
Aviano	2,671.06	269.42	2,401.64	7	2
Camp Darby	2,214.17	213.01	2,201.16	9	9
Incirlik	2,781.74	212.79	2,568.95	7	3
Iraklion	3,814.29	277.30	3,536.99	5	2
Izmir	3,244.50	184.56	3,059.94	6	3
Lajes Field	4,038.64	223.84	3,814.80	5	5
Lakenhealth	2,609.08	231.45	2,377.63	7	6
La Maddalena	2,914.43	316.38	2,598.05	7	7
Naples	2,732.52	328.04	2,404.48	7	2
Rota	3,138.17	311.90	2,826.27	6	2
San Vito	2,908.53	299.24	2,609.29	7	3
Sigonella	2,656.21	223.84	2,432.37	7	4
Upper Heyford	1,781.94	219.32	1,562.62	11	66
Vicenza	2,668.92	267.39	2,401.53	7	10

CHAPTER 4

DISCUSSION

While the preceding demonstrates that RCCS is a cost-effective method to provide medical consultations, these figures were based on all supported hospitals and clinics lumped together. Therefore, individual MTFs were evaluated to determine the feasibility of installing RCCS at each site. Additionally, I wanted to determine if there was enough savings to allow for LARMC to purchase six additional RCCS workstations for installation in the following semi-remote clinics under LARMC:

US Army Health Clinic, Bad Kreuznach,

US Army Health Clinic, Baumholder,

US Army Health Clinic, Dexheim,

US Army Health Clinic, Shape,

US Army Health Clinic, Brussels, and

US Army Health Clinic, Wiesbaden.

These clinics are close enough (four hours driving time or less) that outpatients referred to LARMC are not aeromedically evacuated. Rather, they drive themselves, to LARMC. This results in no government funds being spent for their travel. However, if enough savings can be generated by the other MTFs, installing RCCS at these clinics will not

only provide a service (through convenience) for these patients, but should also increase the amount of available specialty care appointments, thereby increasing overall access to the system. This possibility is based on the assumption that it requires more time for a physician to treat a patient in person than via RCCS.

As illustrated in Chapter 3, each clinic which evacuates outpatients to LARMC has its own break-even point. With the exception of Upper Heyford, installing RCCS at each clinic is economically feasible. Due to the pending closures of clinics and hospitals this summer; however, the following MTFs should not receive RCCS, even though some of them showed economic feasibility:

US Air Force Clinic, RAF Upper Heyford,

US Air Force Clinic, Iraklion Air Station, Greece, and

US Air Force Clinic, San Vito Air Station, Italy.

Implementing RCCS at these MTFs was felt to be a waste of funds, as the procurement process would result in equipment not arriving in time to contribute even one consultation. This results in 11 MTS which should be implemented with RCCS. They are:

US Air Force Hospital, RAF Lakenheath, United Kingdom

US Air Force Hospital, Incirlik Air Base, Turkey

US Air Force Clinic, Lajes Field, Azores

US Air Force Hospital, Aviano Air Base, Italy

US Air Force Clinic, Izmir Air Station, Turkey

Naval Hospital, Sigonella

Naval Hospital, Rota

Naval Hospital, Naples

Branch Medical Clinic, La Maddalena

Vicenza MEDDAC, Italy, and

U.S. Army Health Clinic, Camp Darby, Italy.

As stated earlier, 88 of the 353 patients evacuated to LARMC could have effectively received a consult via RCCS. Extrapolation of this figure (88) over the five year life of RCCS equates 1412 individuals. Of course, to serve this number of patients, RCCS would need to be installed at all the sites. However, dividing the break-even point of this study (seven) into 1412 suggests that over 200 sites could receive RCCS and, in theory, still break-even. Therefore, the savings from the original 11 clinics allow for the installation of additional RCCS workstations at the six clinics referred to earlier from which patients travel to LARMC on their own.

An extension of this analysis explores the differences between the cost of treating dependents and active duty personnel. Using the database features of LOTUS 1-2-3, data was separated into these two groups. The average cost of evacuating a dependent was $3393.17. The average cost of treatment using RCCS would have been $272.71, resulting in a savings of $3120.46. This figure is significantly higher than the active duty figure as 150 evacuated dependents had

a total of 88 NMAs. These NMAs added, on average, an additional expenditure of $1932.55 to transport and house. Without NMAs, the average cost would have been $2259.41 The 203 active duty evacuees cost an average of $2645.31. Within this group, an additional cost was the lost duty time, which came to an average of $212.72. Had these patients been treated by RCCS, the cost would have been $258.80, for a savings of $2386.51.

Additionally, potential savings by service were examined. I looked at those cases two standard deviations above the average cost. This threshold was $5435.30, which resulted in 12 cases. Of the 12, ten were dependents of which three were seen by ENT, three by Orthopedic Surgery, and two by Ophthalmology. Because of the data I was able to get from 2nd AES, I do not have the ages of the patients. However, in talking with a number of individuals who routinely work with the evacuated outpatients, I was told that a majority of patients with NMAs are family members under the age of 18 who require an NMA. The clinics visited by the patients whose costs were above two standard deviations are clinics which would be seen by family members under the age of 18. A review of the data indicated that the most expensive portions of the process were the flight costs. The average flight cost for these 12 patients (round trip with NMAs) was $5868.17 while the average cost for the remaining 341 patients was $2010.43. As NMAs significantly

increases the costs, it would appear that using RCCS in procedures that involve patients under the age of 18 produces the greatest amount of savings.

A potential intangible benefit of RCCS became apparent during a Mass Casualty in October 1993 when LARMC received over 70 wounded soldiers after the failed attempt to capture Somalian War Lord Adid. When first notified of the incoming casualties, LARMC received a listing of wounds in very generic terms (i.e., head wound, gunshot wound to buttocks, shrapnel wound to arms, etc.) The medical staff had no idea as to the scope or seriousness of the wounds. The only condition known was that the patients were stable enough for aeromedical evacuation. This caused a high level of anxiety and concern regarding what services would be required for the soldiers upon their arrival. Had there been established RCCS protocols between LARMC and the field hospital at Somalia, images of the wounds, as well as medical narratives, could have been transmitted to LARMC. The pictures of the injuries could have been taken as each patient was being prepared for the flight. The physician could then provide a written narrative after the patients left the hospital. The images and narratives could have then been transmitted to LARMC during the 10-hour flight.

With the information available using RCCS, LARMC staff could have established a better plan of treatment and triage for the mass influx of patients received. After reviewing

the files, more detailed information about the wounds, as well as an organized plan of treatment for each patient would have been ready upon arrival of each patient. Included in this plan would have been such things as the ward each patient would be admitted to, priority for surgery, and assignment of attending physicians.

CHAPTER 5

CONCLUSIONS AND RECOMMENDATIONS

As this study demonstrates, RCCS is a cost-effective method of providing consultations to outpatients normally evacuated to LARMC. Therefore, I recommend that RCCS be installed at the following eleven sites which were included within this study:

US Air Force Hospital, RAF Lakenheath, United Kingdom

US Air Force Hospital, Incirlik Air Base, Turkey

US Air Force Clinic, Lajes Field, Azores

US Air Force Hospital, Aviano Air Base, Italy

US Air Force Clinic, Izmir Air Station, Turkey

Naval Hospital, Sigonella

Naval Hospital, Rota

Naval Hospital, Naples

Branch Medical Clinic, La Maddalena

Vicenza MEDDAC, Italy, and

U.S. Army Health Clinic, Camp Darby, Italy.

Due to the number of bases in Europe that are closing, some of the sites within this study are scheduled to close within the next year, and the cost of RCCS may not be recaptured. Therefore, I recommend the following sites not be considered for RCCS implementation.

US Air Force Clinic, RAF Upper Heyford,

US Air Force Clinic, Iraklion Air Station, Greece, and

US Air Force Clinic, San Vito Air Station, Italy.

Because of the amount of potential savings from the 11 sites to receive RCCS, the six outlying clinics under LARMC could use RCCS for consultation purposes. Since these clinics are within driving range of LARMC, they will not save money. However, if these clinics utilized RCCS, appointments at LARMC's specialty clinics, currently filled by patients treatable using RCCS, would become available, increasing for all authorized beneficiaries. Therefore, I recommend that the following clinics also be implemented with RCCS:

US Army Health Clinic, Bad Kreuznach,

US Army Health Clinic, Baumholder,

US Army Health Clinic, Dexheim,

US Army Health Clinic, Shape,

US Army Health Clinic, Brussels, and

US Army Health Clinic, Wiesbaden.

As this study illustrates the significant cost of aeromedically evacuating children, I recommend that procedures be set in place to ensure maximum use of RCCS to treat outpatients under 18 years of age. Such a policy would significantly reduce healthcare costs as fewer of these patients, and their NMAs, would require military transportation to LARMC.

With the increasing number of Humanitarian Missions that the military is conducting, I also recommend that procedures be established for utilizing RCCS when evacuating wounded personnel. Receiving images and narratives prior to arrival of these patients allows LARMC staff to develop more efficient triage and treatment plans.

In conclusion, this project required coordination with Air Force, Navy, and Army personnel at different levels, as well as an abundance of data entry and manipulation. The results support RCCS as a method of providing quality care, at a reduced cost, while increasing access to the system. These three components, cost, quality, and access, identified by Victor R. Fuchs (1974) in his classic book Who Shall Live?, are as important today as they were over twenty years ago when first published. The only difference is that with the heightened awareness of healthcare costs and the debate of healthcare reform, these tenets are even more important as new and exciting ways of delivering the best healthcare, at the lowest cost are explored.

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